

# Overview of Bioenergy Development in California

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**Presentation to Southern California Gas Company's**

**Third Annual Business Energy Efficiency Expo**

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***Southern California Gas Company, Energy Resource Center***

***9240 East Firestone Blvd., Downey, CA***





## Outline

- Introduction - California Energy Commission
- California's Energy Picture
- Biomass Policy Drivers
- Biomass Conversion Pathways
- Status of Bioenergy in California
- Public Interest Energy Research Program
- PIER Biomass Research Activities
- Dairy Power Production Program
- Production Incentives for Biomass
- Energy Efficiency and Biomass Generation  
Agricultural Loan Program
- Concluding Remarks





The **California Energy Commission** is the state's primary energy policy and planning agency. Created by the Legislature in 1974 and located in Sacramento, California.

**The Commission has five major responsibilities:**

- Forecasting future energy needs and keeping historical energy data
- Licensing thermal power plants 50 megawatts or larger
- Promoting energy efficiency through appliance and building standards
- Developing energy technologies and supporting renewable energy
- Planning for and directing state response to energy emergency



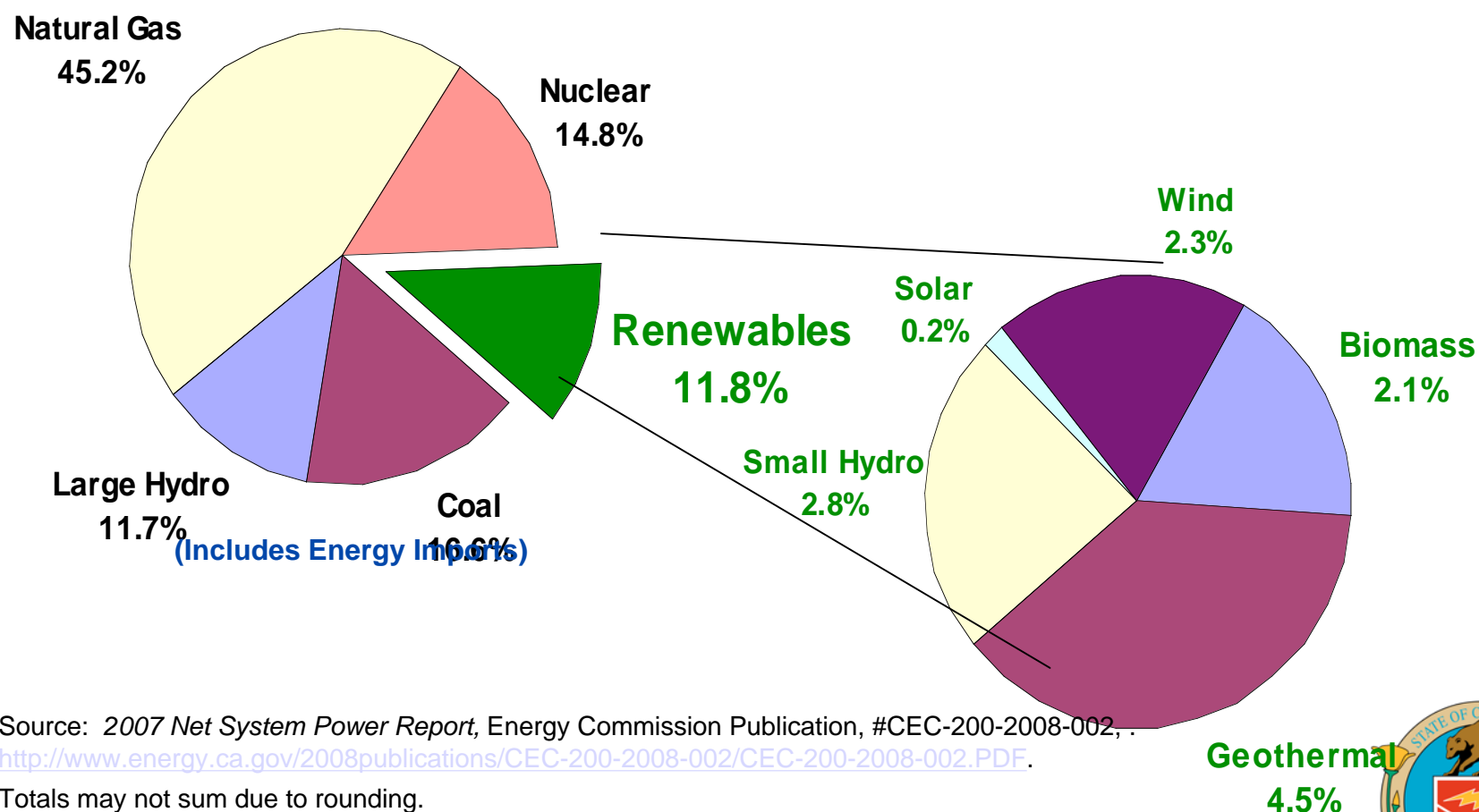


- With the signing of the Assembly Bill 1890 in 1998, the Commission's role includes:
  - overseeing funding programs that support public interest energy research (PIER); advance energy science and technology through research, development and demonstration; and
  - provide market support to existing, new and emerging renewable technologies.
- With energy challenges facing the state, the Commission and its dedicated staff --stand ready to turn challenges into opportunities and help Californians continue to have energy choices that are affordable, reliable, diverse, safe and environmentally acceptable.



# California's Electricity Supply in 2007

**In-State Generation and Estimated Energy Imports by Fuel Type**  
(Total: 209,856 GWh)



Source: 2007 Net System Power Report, Energy Commission Publication, #CEC-200-2008-002, .  
<http://www.energy.ca.gov/2008publications/CEC-200-2008-002/CEC-200-2008-002.PDF>.

Totals may not sum due to rounding.

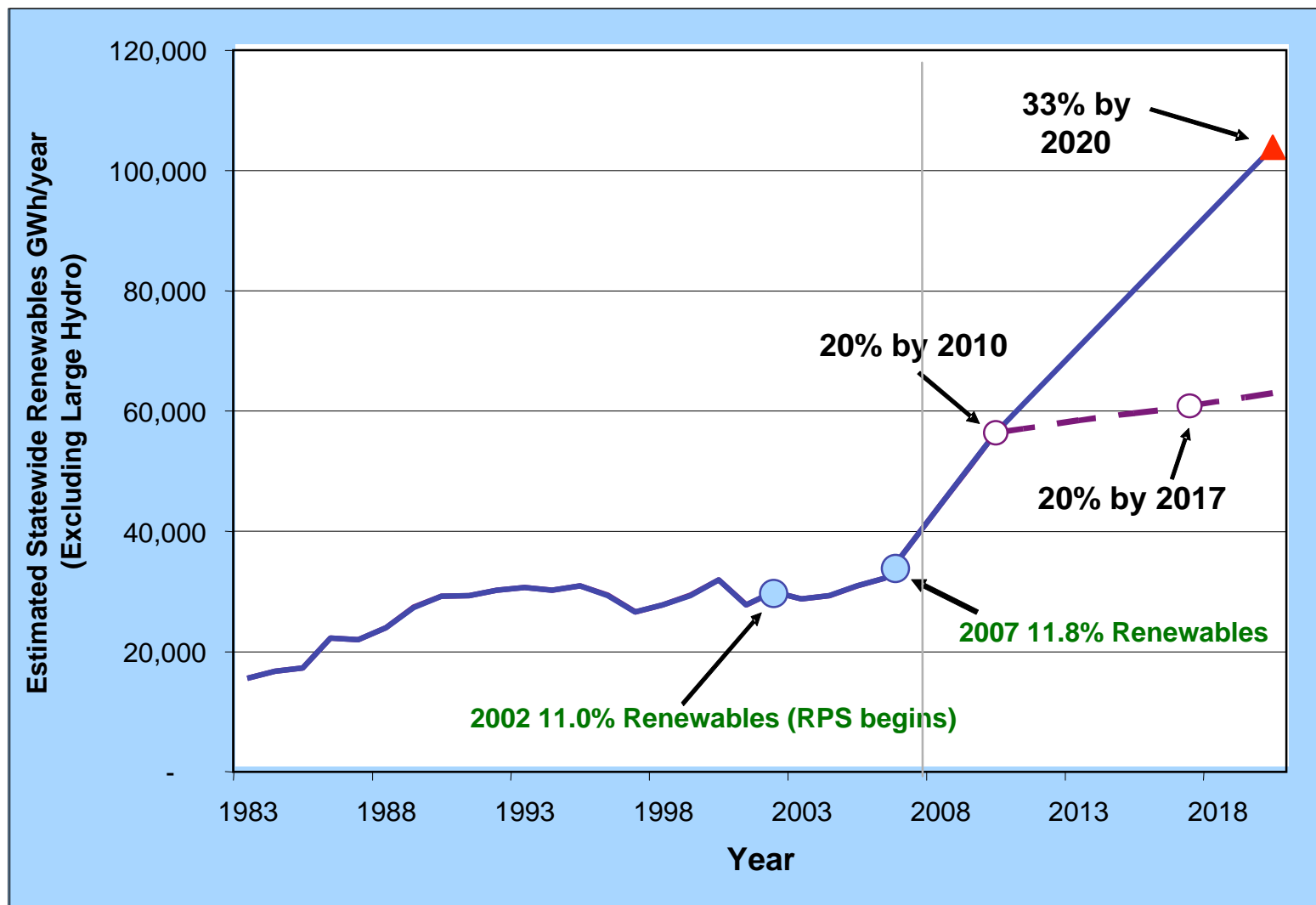


# California Biomass Energy Policy Drivers

- Governor's Executive Order S-06-06 –biomass & biofuels
- Bioenergy Action Plan (July 13, 2006, Governor announces action plan to reduce petroleum dependence and improve air quality)
- AB 32 – Global Warming Solutions Act
- Governor's GHG Reduction Targets (Executive Order S-3-05)
- Renewables Portfolio Standard, 20% by 2010 and 33% by 2020
- Integrated Energy Policy Reports (IEPR) (2003, 2004 update, 2005)
- Energy Action Plan (EAP) I and II (published 2003 and 2005 respectively)
- Governor's 2003 / 2004 IEPR response and Ten Point Plan
- US 2005 Energy Policy Act
- Western Governor's Association (Charter, 2005 Annual Report, 2003 Policy Roadmap)



# California's Renewable Energy Goals







## Executive Order S-06-06

- By 2010, producing 20 percent of its biofuels within California, increasing to 40 percent by 2020 and 75 percent by 2050, and
- By 2010, producing 20 percent of the renewable electricity generated from biomass resources within the State and maintaining this level through 2020.






-The Governor directed several state agencies to take major steps toward the widespread use of biomass to produce clean, renewable transportation fuels or electricity.

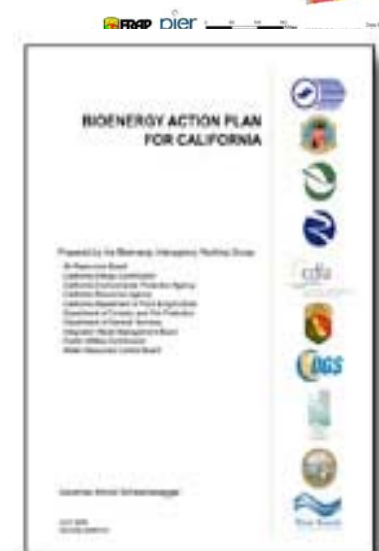
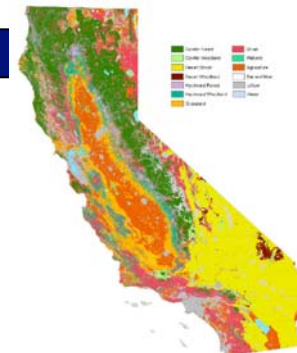
***--Reinvigorated the*** Bioenergy Interagency Working Group through the help of the California Biomass Collaborative





## Bioenergy Action Plan Objectives

-  Establish California as a market leader in technology innovation, sustainable biomass development, and market development for bio-based products.
-  Coordinate research, development, demonstration, and commercialization efforts across federal and state agencies. ----Develop biomass roadmap.
-  Align existing regulatory requirements to encourage production and use of California's biomass resources.
-  Facilitate market entry for new applications of bioenergy including electricity, biogas, and biofuels.
-  Maximize the contributions of bioenergy toward achieving the state's petroleum reduction, climate change, renewable energy, and environmental goals.



## Biomass power and capacity needed to meet 20% share of accelerated RPS

|      | RPS (%) | Renewable power under RPS (GWh/y) | 20% Biomass goal (GWh/y) | Biomass capacity required above current 2005 (MW- 0.85 cap. Factor) |
|------|---------|-----------------------------------|--------------------------|---|
| 2010 | 20      | 58,575                            | 11,700                   | 575   |
| 2020 | 33      | 109,400                           | 21,875                   | 1,975   |
| 2050 | 33      | 136,500                           | 27,300                   | 2,670   |



# Biofuel Goals

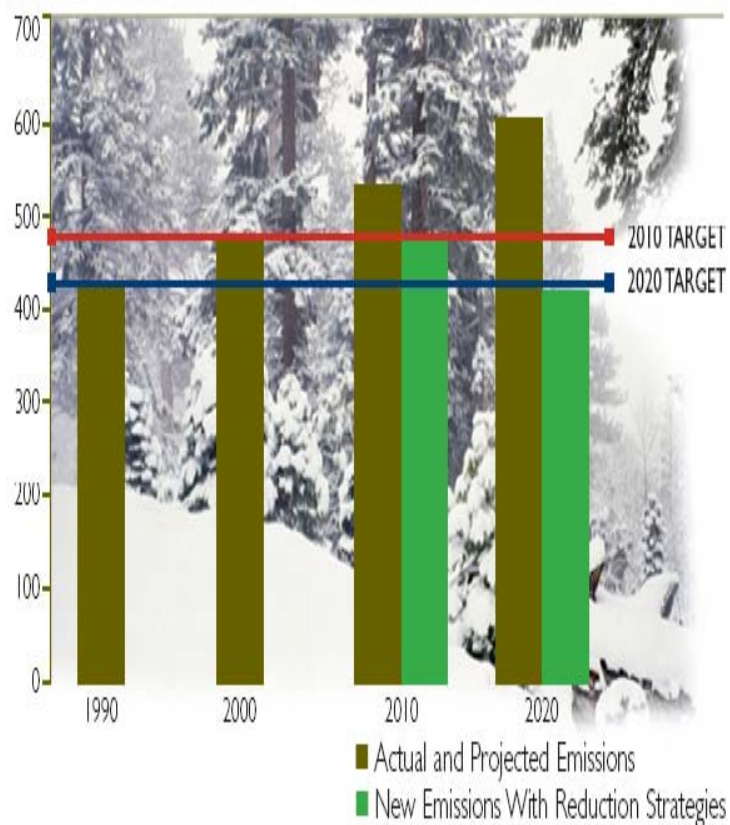
**Executive Order S-06-06 and Bioenergy Action Plan articulated goals for in-state biofuel production (i.e., by 2010 20% of state's biofuel should be produced in-state, increasing to 40% by 2020, and 75% by 2050)**

Instate biofuel goals (million gallons per year)

| Year | Ethanol |       |       |     | Biodiesel |     |       |
|------|---------|-------|-------|-----|-----------|-----|-------|
|      | E5.7    | E10   | E20   | B2  | B5        | B10 | B20   |
| 2010 | 183     | 325   | 675   | 13  | 32        | 65  | 130   |
| 2020 | 390     | 700   | 1430  | 35  | 85        | 170 | 345   |
| 2050 | 900     | 1,570 | 3,250 | 150 | 375       | 750 | 1,490 |



## 2006 Legislation Provides New Policy Goals and Urgency for California Energy Sectors

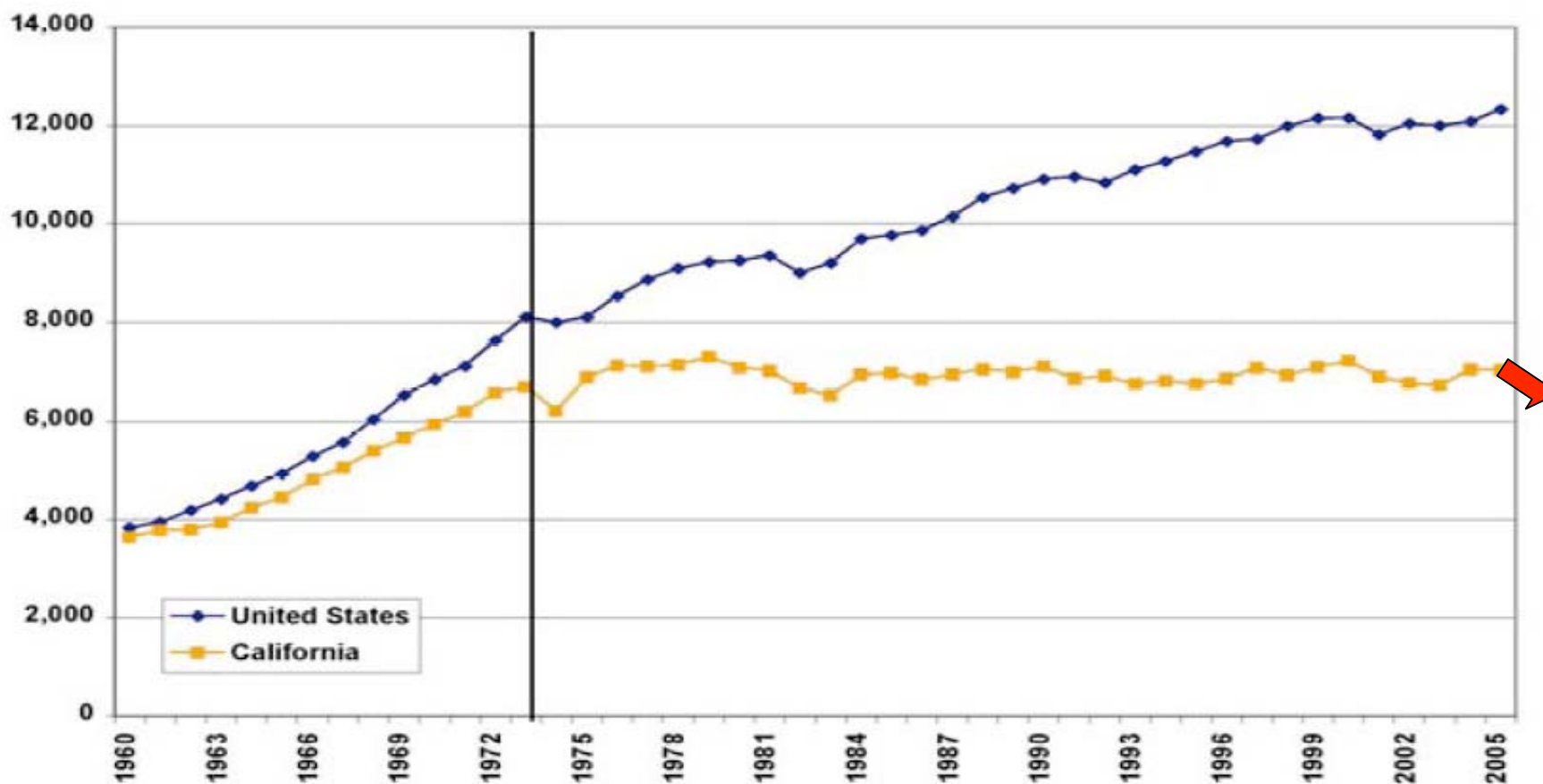


- **AB 32 – Global Warming Solutions Act of 2006; aggressive goals for 2020**
- SB 1368 – GHG Emissions standards for Municipal Utilities
- AB 2021 – Energy Efficiency for Municipal Utilities
- AB 2160 – Green Building Acquisition Financing for State Facilities
- **SB107 – Accelerated RPS Goals**
- SB1 – PV and Renewables Goals for New and Existing Residential and Commercial Structures
- AB 2778 – Self-Generation Incentive Program for Fuel Cells and Wind
- SB 1250 – PIER and Renewables Incentive Programs Reauthorized



# Total Electricity Use Per Capita needs to decline

Per Capita Electricity Sales in kWh



*Efficiency has reduced the growth of CA electricity use but new resources are still needed.*

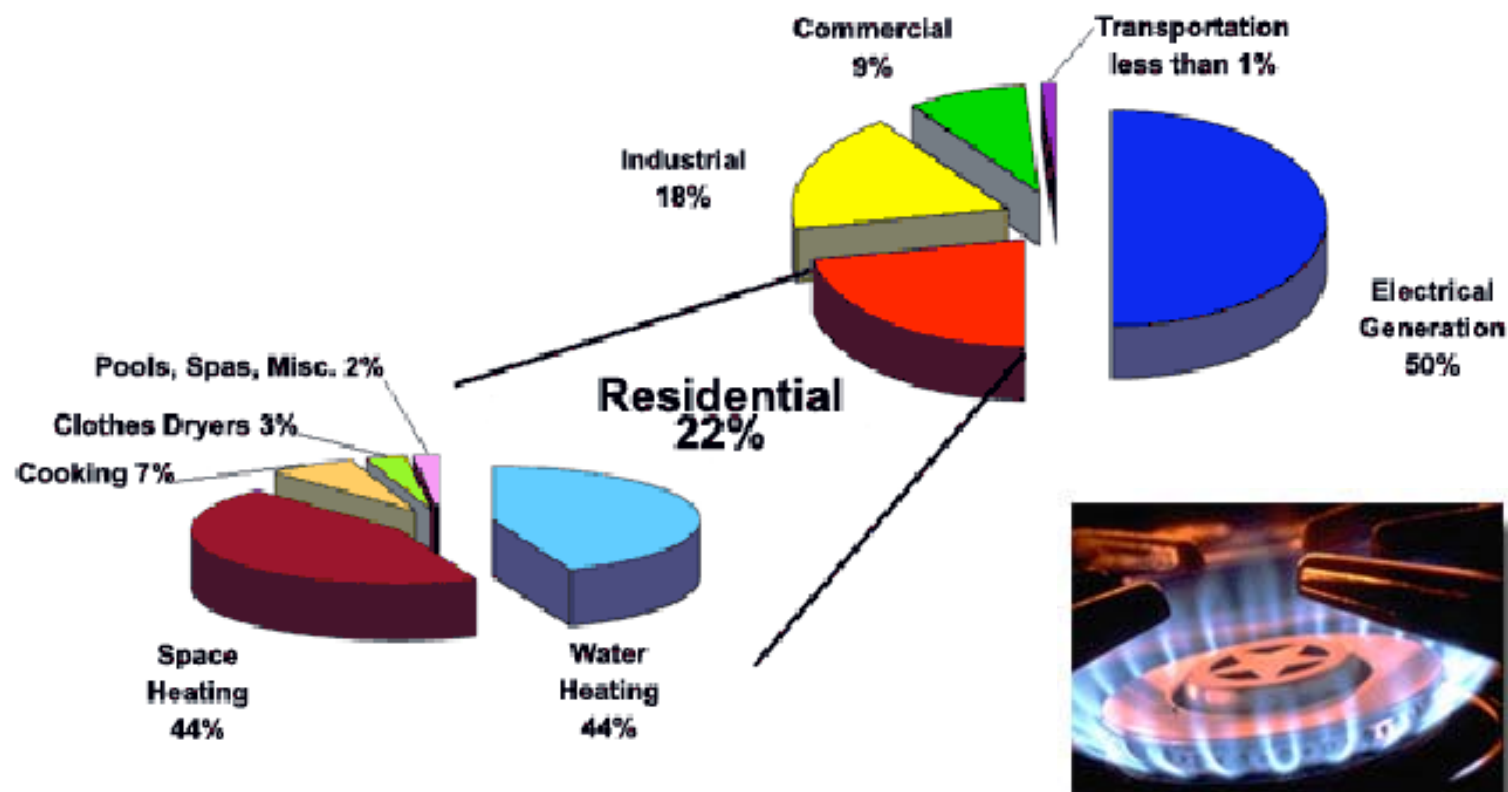
Source: <http://www.energy.ca.gov/2007publications/CEC-100-2007-008/CEC-100-2007-008-CMF-ES.PDF>





# 2004 Natural Gas Use in California

2004 Natural gas consumption ~ 228 Bcf

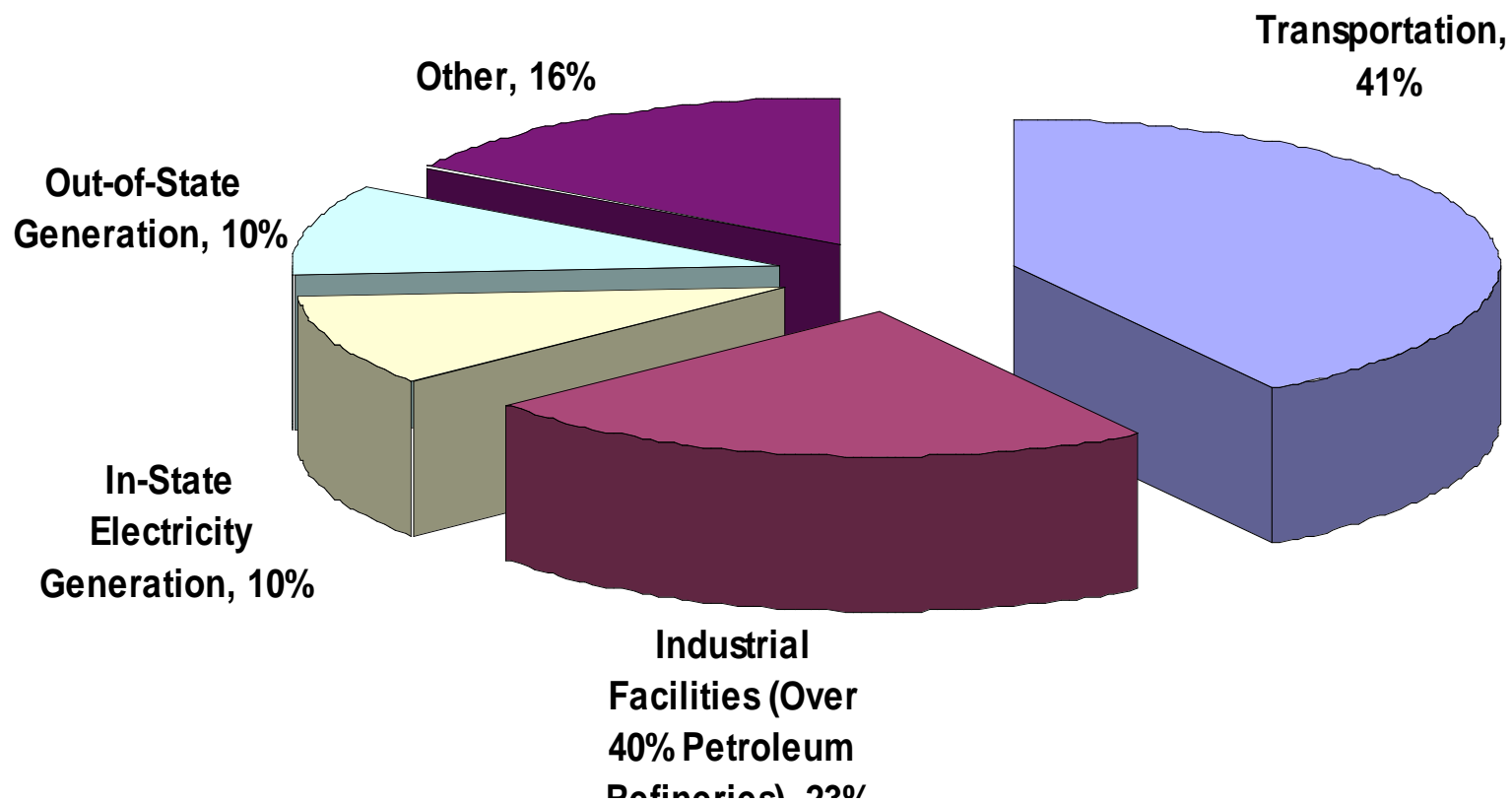


*Biogas can displace natural gas broadly in direct uses.*



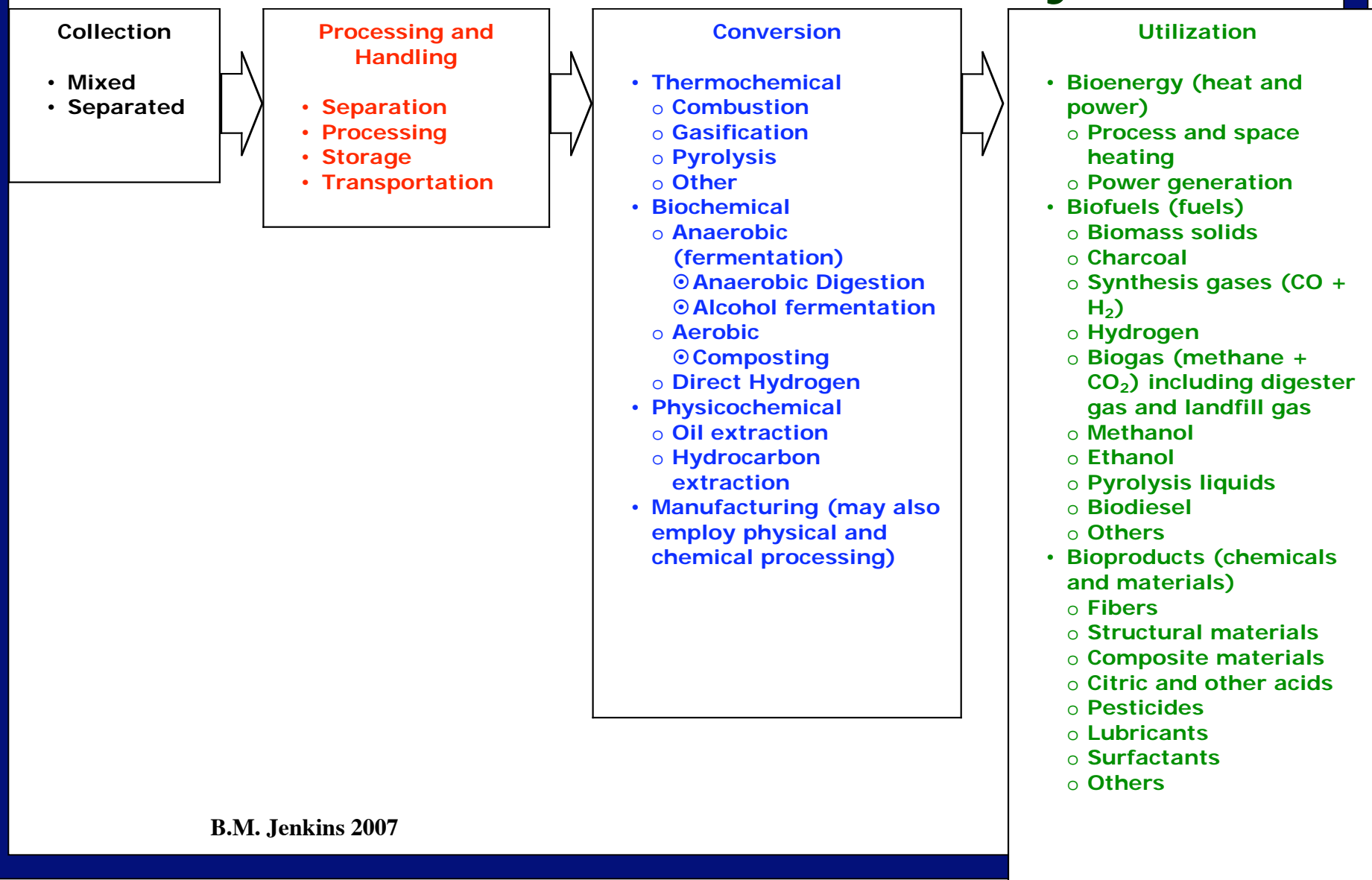
# California Greenhouse Gas Emissions

The total GHG emissions for 2004 are ~500 million tons of CO<sub>2</sub> equivalent



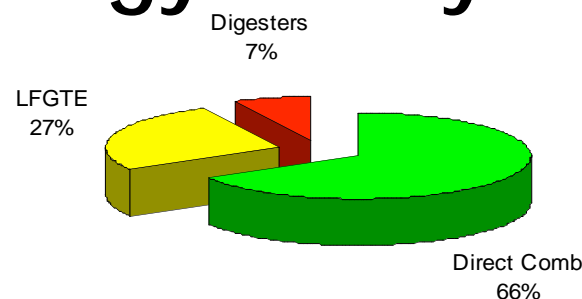


# Biomass Conversion Pathways



# California Bioenergy Today

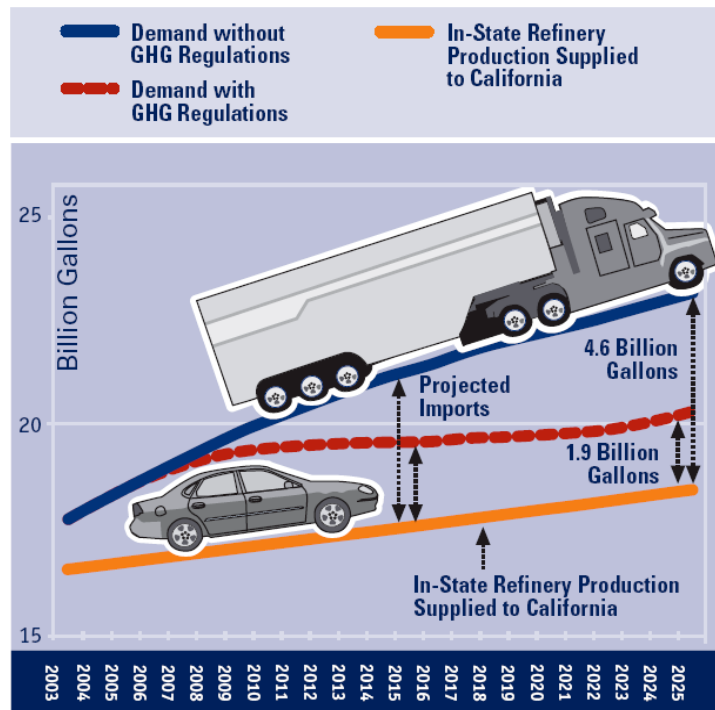
- Biomass Energy Facilities Provide ~1000 MW of Electricity Capacity through
  - Direct Combustion of Forestry, Ag and Urban Biomass
  - Landfill Gas to Energy (LFGTE) Facilities Convert Methane Rich Landfill Gas
  - Wastewater and Dairy Biogas Systems Process Biogas Into Useful Energy
- Biofuels - California consumes over 900 million gallons per year of ethanol and over 11 million gallons of biodiesel fuel.



## Trends Petroleum and Non-Petroleum Consumption

The 2005 IEPR concluded that California needs to aggressively reduce its dependence on petroleum and introduce more non-petroleum options.

### *Projected Gasoline and Diesel Demand*



Source: California Energy Commission, November 2005, 2005 Integrated Energy Policy Report

### *Demand for Gasoline and Diesel Fuel*

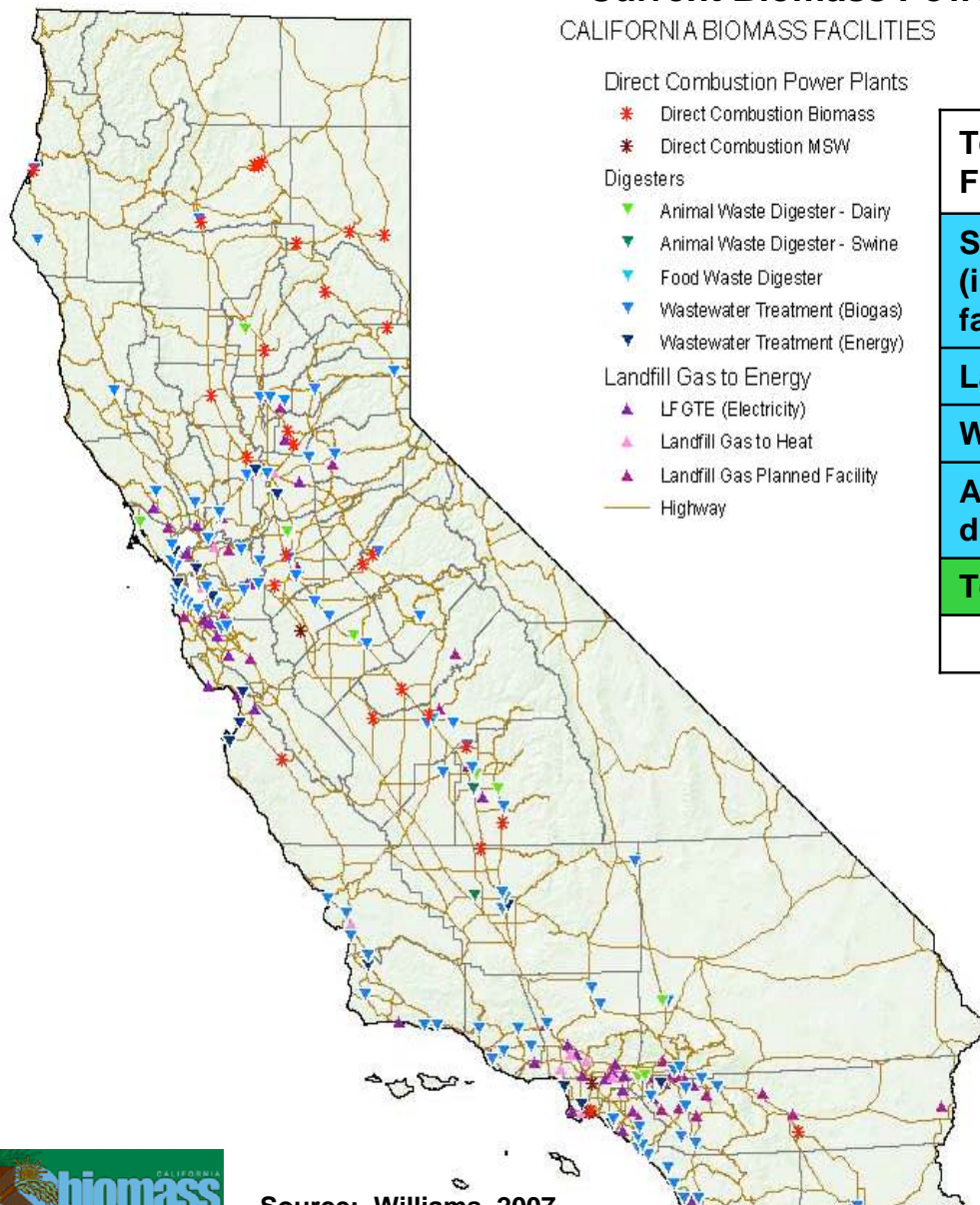
Demand continues, even in the face of record petroleum prices, for several reasons:

- Population growth and more on-road vehicles
- Low per-mile cost of gasoline for the past two decades
- Lack of alternatives to conventional gasoline and diesel fuels
- Consumer preference for larger, less fuel efficient vehicles
- Land use planning that places jobs and housing farther apart without transportation integration
- Lack of mass transit



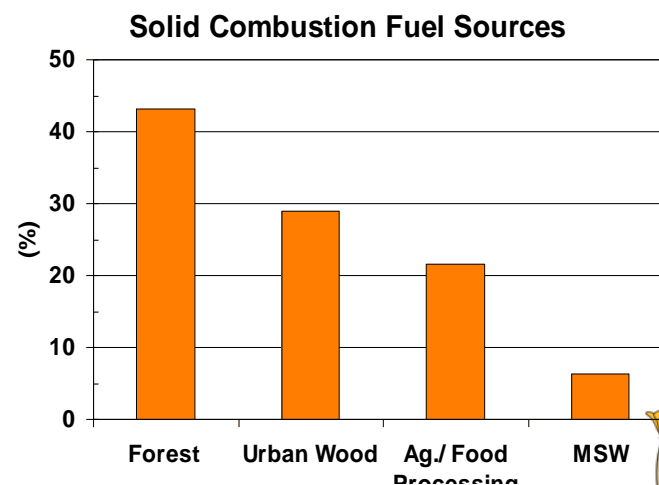
## Current Biomass Power Capacity in California

### CALIFORNIA BIOMASS FACILITIES



| Technology/<br>Fuel Source                                       | Number of<br>facilities | Gross<br>Capacity (MW) |
|--|-------------------------|------------------------|
| <b>Solid Fuel Combustion<br/>(includes 3 MSW<br/>facilities)</b> | <b>30</b>               | <b>640</b>             |
| <b>Landfill gas-to-energy</b>                                    | <b>60</b>               | <b>275</b>             |
| <b>Wastewater treatment *</b>                                    | <b>20</b>               | <b>64</b>              |
| <b>Animal and food waste<br/>digester</b>                        | <b>22</b>               | <b>5.7</b>             |
| <b>Totals</b>  | <b>132</b>              | <b>985</b>             |

**\* Suspect - Probably higher**



Source: Williams, 2007



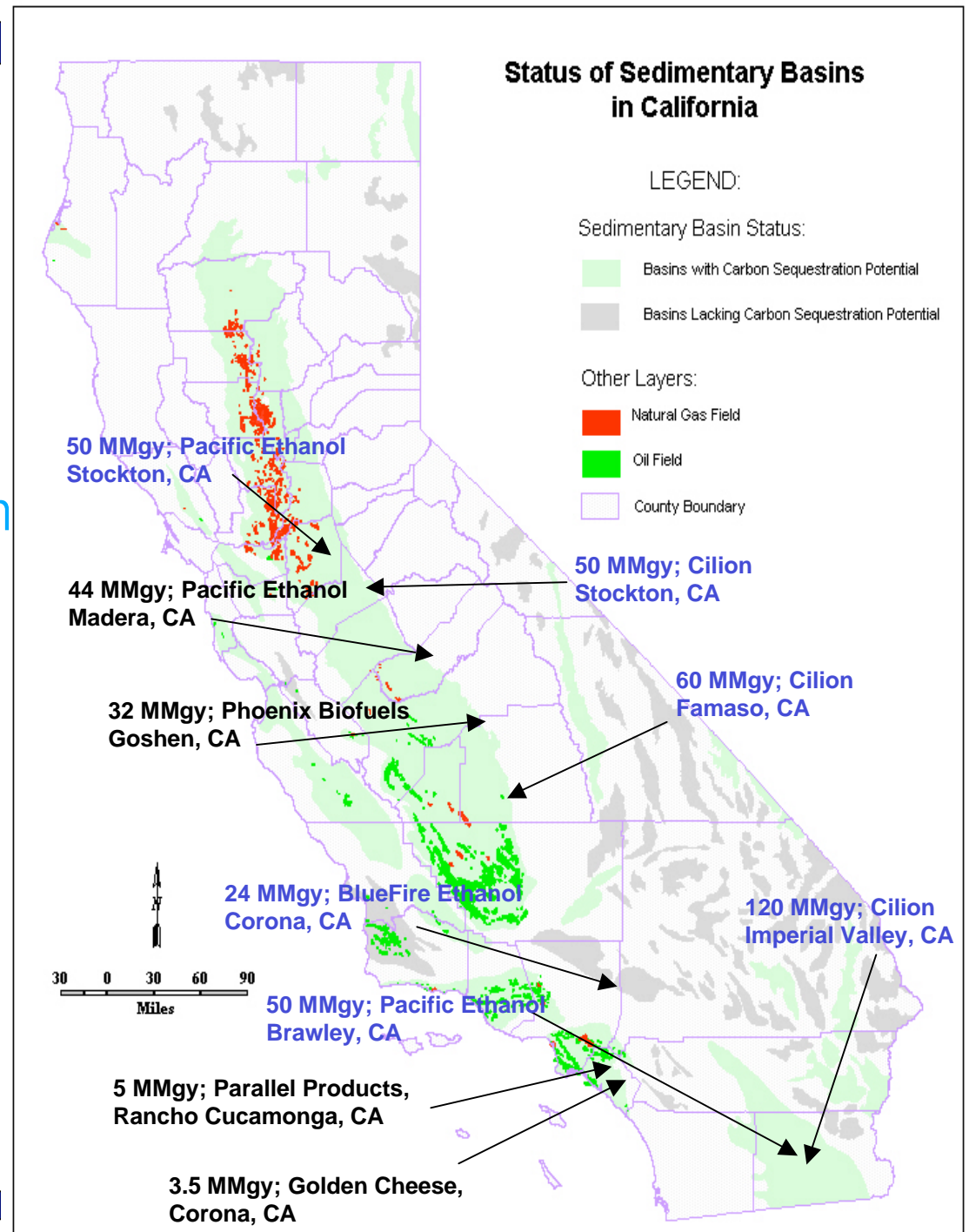
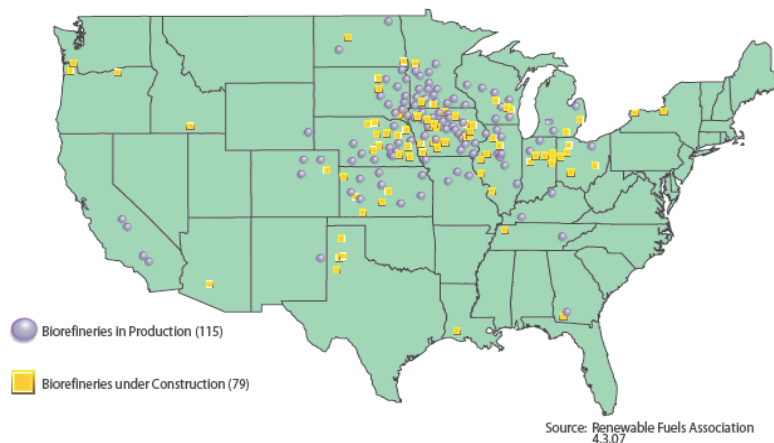


## Ethanol Facilities in California (2007)

- Existing ethanol facilities (81 Million Gallons)
- Proposed plants (853 Million Gallons)

Note: other proposed plants not shown

### U.S. Ethanol Biorefinery Locations



# Biodiesel Production in California

## 46.5 million gallons (2008)

| <i>Plant Name</i>                     | <i>City</i> | <i>Feedstock</i>              | <i>Capacity in millions of gallons per year</i> |
|---------------------------------------|-------------|-------------------------------|---|
| Bay Biodiesel LLC                     | San Jose    | Virgin oils/<br>Yellow grease | 5   |
| Bio-Energy Systems, LLC               | Vallejo     | Virgin oils/<br>Yellow grease | 2   |
| Biodiesel Industries-<br>Port Hueneme | Ventura     | Multi-feedstock               | 3   |
| Blue Sky Bio-Fuels, Inc.              | Oakland     | Multi-feedstock               | 20  |
| Energy Alternative<br>Solutions, Inc. | Gonzales    | Tallow                        | 2.5   |
| Imperial Western Products             | Coachella   | Yellow grease                 | 12  |
| LC Biofuels                           | Richmond    | Canola oil                    | 1   |
| SoCal Biofuels                        | Anaheim     | White vegetable oil           | 1   |

*Total Capacity: 46.5*

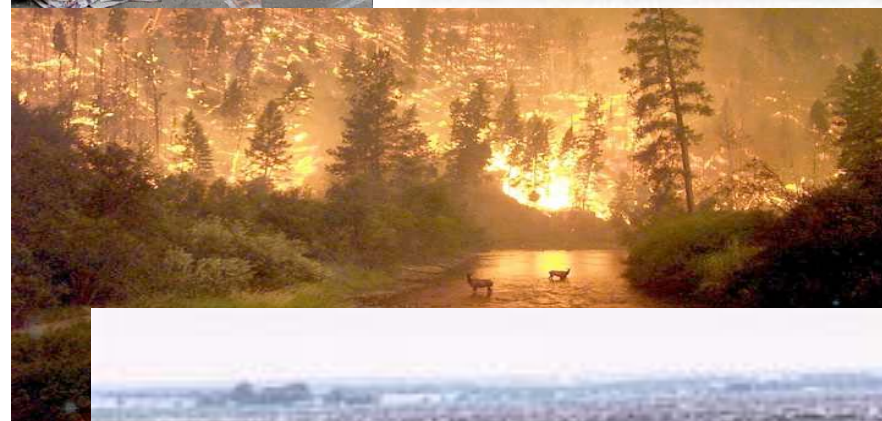
**Source:**

<http://www.biodieselmagazine.com/plant-list.jsp?view=production&sort=name&sortdir=desc&country=USA>



# Today Biomass Is Viewed as a Disposal Problem

- Reducing Landfill Capacity
  - About 40 million tons of biomass goes into landfills every year
- Contributing to Air Pollution and Fire Risk
  - Open field burning of crop residues emits more than 100,000 tons of air pollutants annually
  - Wildfires contribute over 1.1 million tons per year at a cost of >\$900 million/year
- Local Concerns
  - California's 1.67 million dairy cows generate odor and health concerns





## Public Interest Energy Research (PIER) Program

- **IOU Ratepayer-funded program launched in 1997**
- **Addresses electricity, natural gas, and transportation sectors**
- **~\$80M annual budget; nearly \$400M in projects**
- **A leader in no/low-carbon technology and global climate change research programs**
  - Efficiency and Demand Response
  - Renewables
  - Clean Fossil Fuel Generation – Distributed Generation, Combined Heat & Power
  - Transportation
  - Energy Systems Research – Transmission and Distribution, Grid Interconnection
  - Environmental Impacts – Air, Water, Climate, Communities
- **Strong emphasis on collaborations**
  - Avoid duplication/builds on past work/ensures relevance
  - Regular coordination with IOUs via the Emerging Technology Coordinating Council to transition research to the marketplace
  - State Agency Partnerships (DGS/DOF, ARB, T-24,CDF,CAGR,CalEPA, IWMB)
  - Market Partnerships (California builders, Collaborative for High Performance Schools, California Commissioning Collaborative, major equipment manufacturers)
  - Use California Capabilities (Universities, National Laboratories, High Technology Companies)
  - Leverage/complement Federal Investments



## PIER Goals Are Solution- Focused and Include Biomass

### General Goal

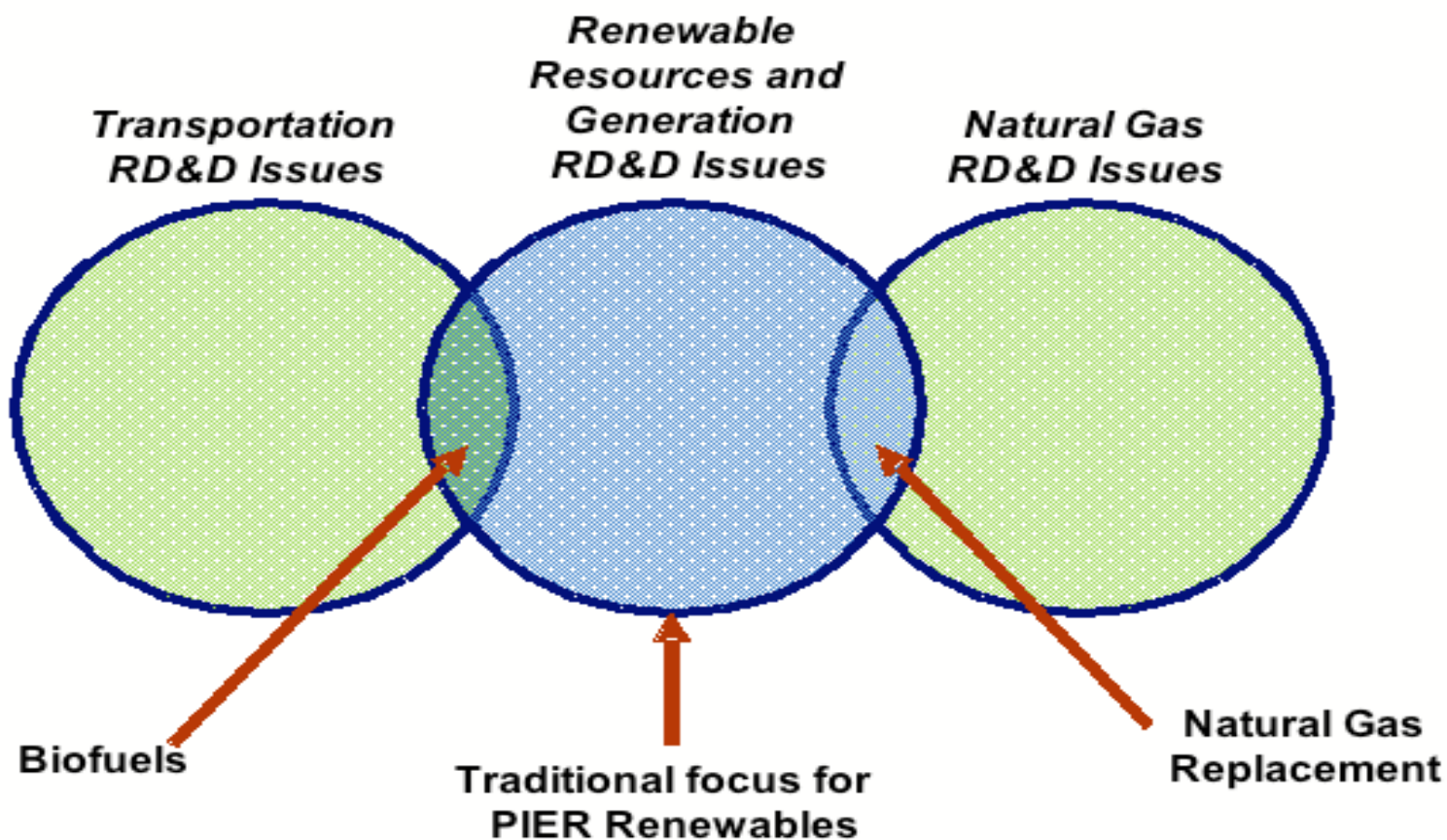
- “Develop and help bring to market, energy technologies that provide increased environmental benefits, greater system reliability, and lower system costs”

### Specific Goals

- Develop and help bring to market
  - “Advanced transportation technologies that reduce air pollution and greenhouse gas emissions beyond applicable standards, and that benefit electricity and natural gas ratepayers.
  - “Increased energy efficiency in buildings, appliances, lighting, and other applications beyond applicable standards, and that benefit electric utility customers.
  - “Advanced electricity generation technologies that exceed applicable standards to increase reductions in greenhouse gas emissions from electricity generation, and that benefit electric utility customers.
  - “Advanced electricity technologies that reduce or eliminate consumption of water or other finite resources, increase use of renewable energy resources, or improve transmission or distribution of electricity generated from renewable energy resources.”



## PIER Renewables Program RD&D Focus



# Stages of Technology Development & PIER Renewables Role

| Stages of Technology Development  |  |   |  |   |
|---|--|---|--|---|
| Research  | Development  | Demonstration   | Commercialization  |   |
|   |  |   | Market Entry   | Market Penetration  |
| <ul style="list-style-type: none"> <li>• General assessment of resources and market needs</li> <li>• Assess general magnitude of economics</li> <li>• Concept and bench testing</li> <li>• Basic research and sciences (e.g., materials science)</li> </ul> | <ul style="list-style-type: none"> <li>• Research on component technologies</li> <li>• Development and initial of product offering</li> <li>• Pilot testing</li> </ul> | <ul style="list-style-type: none"> <li>• Integrate component technologies</li> <li>• Initial system prototype for debugging</li> <li>• Demonstrate basic functionality</li> <li>• Ongoing development to reduce costs or for other needed improvements</li> <li>• "Technology " (systems) demonstrations</li> <li>• "Commercial " demonstration</li> <li>• Standards creation</li> <li>• Testing and certification</li> </ul> | <ul style="list-style-type: none"> <li>• Initial orders</li> <li>• Early movers or niche segments</li> <li>• Product reputation is initially established</li> <li>• Business concept implemented</li> <li>• Market support usually needed to address high production cost</li> </ul> | <ul style="list-style-type: none"> <li>• Follow - up orders based on need and product reputation</li> <li>• Broad(er) market penetration</li> <li>• Infrastructure developed</li> <li>• Full - scale manufacturing</li> </ul> |

## PIER Renewables Technology Research

PIER Renewables co -funds research for renewable technologies from applied research to the demonstration stage

## PIER Renewables Policy and Adoption Support Research

PIER Renewables funds research to support policy development, ad option and integration for renewables energy technologies in all stages of development



# Biomass Technology Gaps

- Electricity Generation Gaps
  - Costs still need to come down to more competitive levels
  - Air emission profiles (esp. NO<sub>x</sub>) need to meet or exceed regulations (e.g., CARB 2007 guidelines)
  - At utility-scale sizes, need development of super clean, super-efficient systems with high degree of responsiveness
  - At DG levels - small modular-scale, need to develop a track record
- Transportation Technology Gaps
  - Lack of commercial cellulosic to ethanol technologies
    - ◆ Development and demonstration of cellulosic facilities
    - ◆ Development of track record on performance and cost
    - ◆ Development of infrastructure for production & delivery of fuel
  - Lack of track record for biodiesel



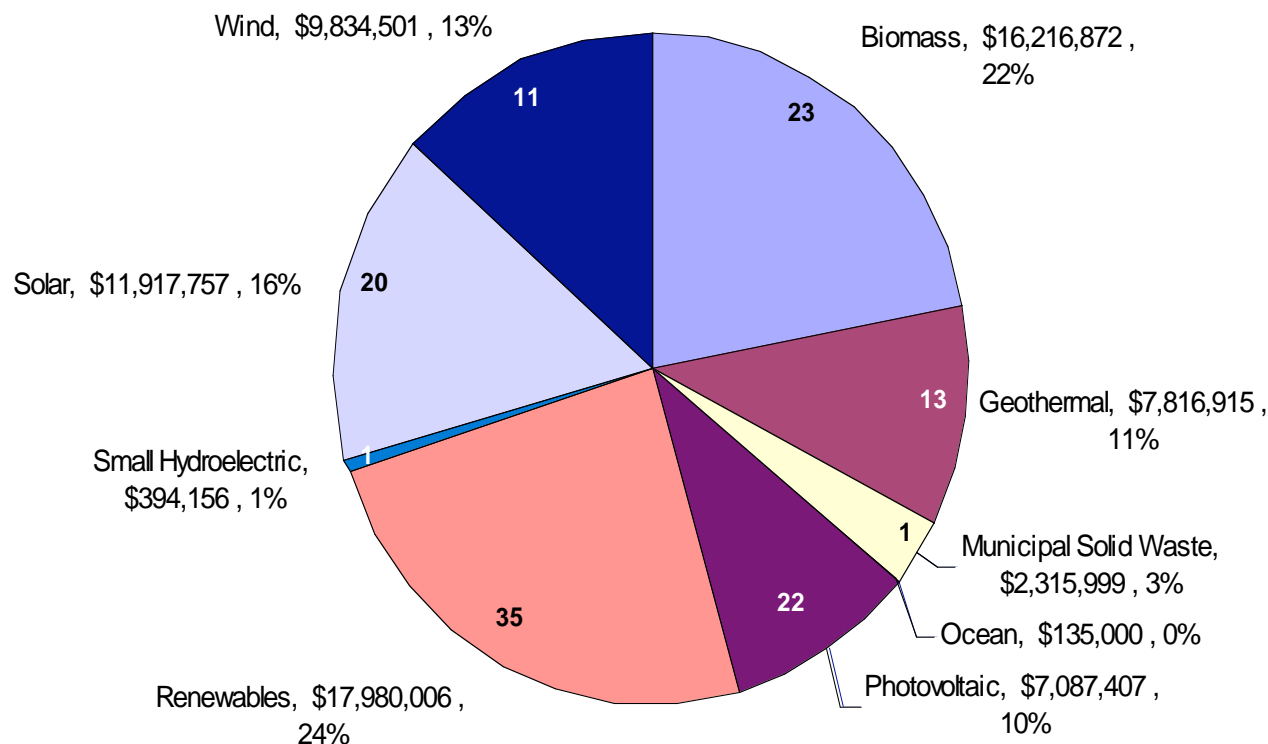
# Biomass RD&D Activities

- Technology Development
  - Direct Combustion/Co-Firing/Hybrid Systems
  - Biogas
  - Thermal Gasification and Pyrolysis
  - Biofuels and Biorefineries
- Analysis and Planning
  - California Biomass Collaborative Support
    - ◆ Biomass Roadmap for biomass development
    - ◆ Biomass Resource Assessments
    - ◆ Biomass Performance Reporting System
    - ◆ Fifth Biomass Forum on May 27-30, 2008
  - Strategic Value Analysis
    - ◆ Linking cost competitive biomass resources to electricity system needs while addressing public benefits
- Natural Gas Replacement by Biomass
  - Implement Natural Gas RD&D Program Plan
  - PIER Transportation RD&D



# PIER Portfolio Summary

**Renewables Projects - Active and Closed**  
**128 Projects, \$73.7 Million**

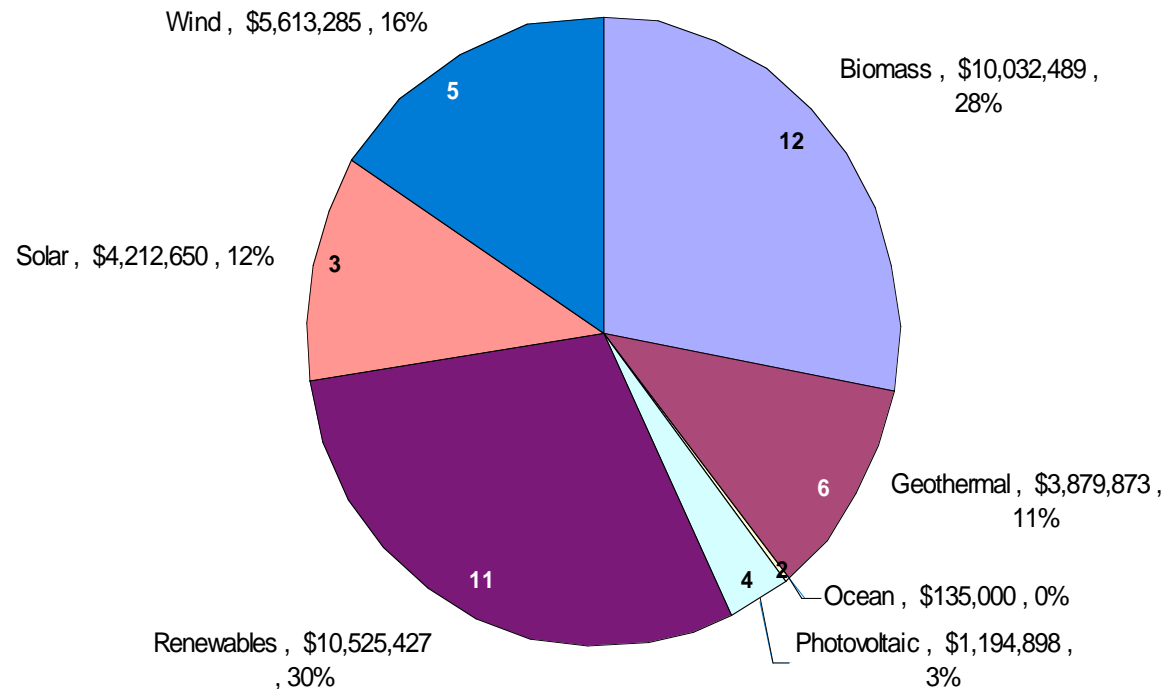




# PIER Portfolio Summary

## Renewables Projects - Active

43 Projects, \$35.6 Million



# Resource Assessments



# California Energy

## Agriculture

## Forestry

## Urban

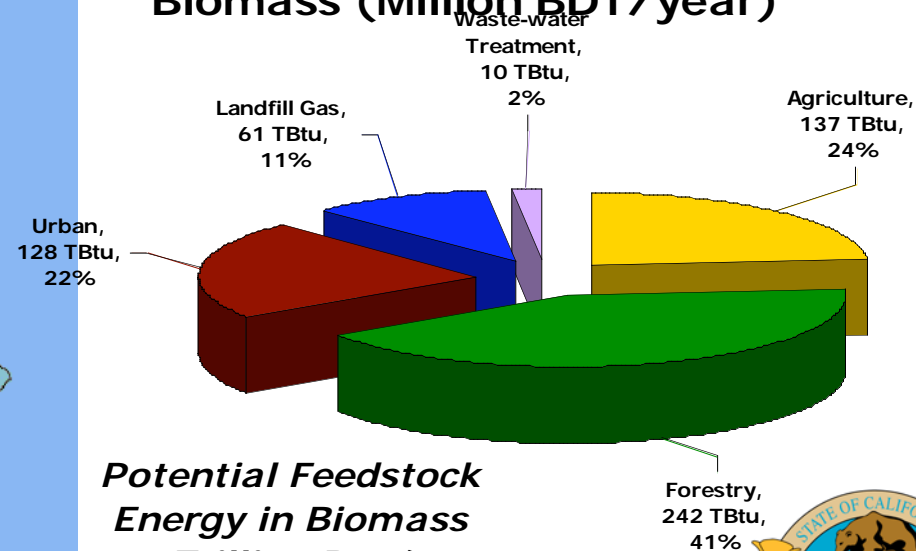
## Total

■ Potential Feedstock  
■ Gross Biomass

+ 137 BCF/year landfill and digester gas

0 20 40 60 80 100

Biomass (Million BDT/year)



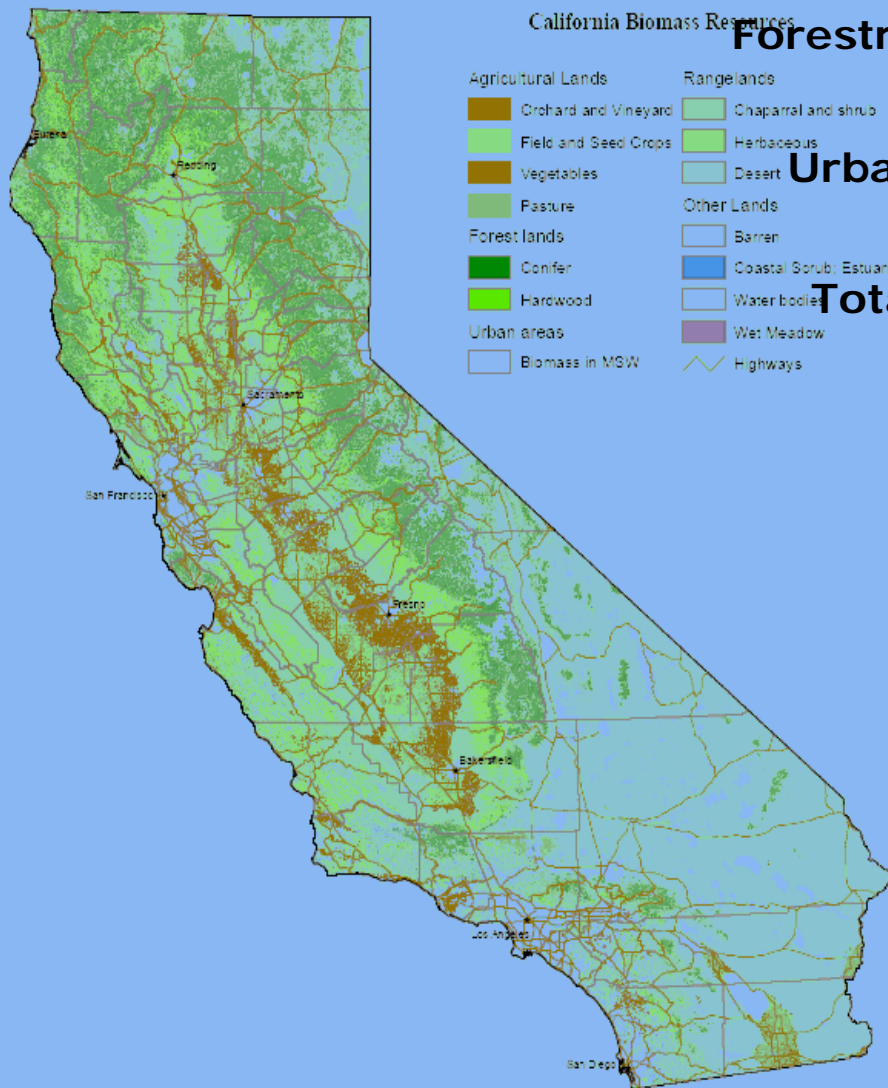
**Potential Feedstock  
Energy in Biomass  
507 Trillion Btu/year**



# California Biomass Resources

## California Biomass Resources

- |                           |                          |
|---------------------------|--------------------------|
| <b>Agricultural Lands</b> | <b>Rangelands</b>        |
| Orchard and Vineyard      | Chaparral and shrub      |
| Field and Seed Crops      | Herbaceous               |
| Vegetables                | Desert                   |
| Pasture                   | Other Lands              |
| <b>Forest lands</b>       | Barren                   |
| Conifer                   | Coastal Scrub/ Estuarine |
| Hardwood                  | Water bodies             |
| <b>Urban areas</b>        | Wet Meadow               |
| Biomass in MSW            | Highways                 |



0 20 40 60 80 100 Miles

Data source: CFE/VEG 2002 Version 2

# Total Categorical Bioenergy Potentials in California

| Category                    | Biomass<br>(Million BDT/year)   | Energy in Product<br>(Trillion Btu/year) | Total Capacity                 |
|-----------------------------|---------------------------------|--|--------------------------------|
| Electricity<br>CHP Heat     | 32                              | 118 (35 TWh)<br>230                      | 4,650 MWe<br>9,050 MWt         |
| Heat                        | 32                              | 350                                      | 11,700 MWt                     |
| Biochemical<br>Biofuel      | 32                              | 188                                      | 1.5 BGY<br>gasoline equivalent |
| Thermochemical<br>Biofuel   | 27*                             | 250                                      | 1.7 BGY<br>diesel equivalent   |
| Biomethane                  | 5 +<br>Landfill gas and<br>WWTP | 106                                      | 106 BCF/y<br>methane           |
| Hydrogen<br>(bio + thermal) | 32                              | 305                                      | 2.5 Million tons/y             |

\* Tonnage for thermochemical biofuel assumed to be constrained by moisture content

Current California consumption:

16 billion gallons gasoline + 4 billion gallons diesel = 2,500 Trillion Btu/year direct energy content

300 TWh/y electrical energy = 1,024 Trillion Btu/year direct energy



## PARTNERSHIPS – RESOURCES – KNOWLEDGE BASE

### Mission

- To enhance the sustainable management and development of biomass in California
- Provide a forum for industry, government, academic, and environmental community interactions

## California Biomass Collaborative



## Projects:

- Supporting and providing expertise to enhance biomass R&D program mission and strategy (short & long term)
- Established focal center - Statewide biomass coordinating group
- Updated biomass resource assessments
- Building Biomass Facilities Reporting System
- Power generation assessments or Technology assessments
- White papers, newsletters
- Annual Forums
- Cost calculators
- Supported IEPR process
- Coordination with State Interagency Working Group
- Roadmap for biomass development
- Biomass Roadmap – Public workshop on Nov 16, 2006



# California Biomass Roadmap

*Vision: Sustainable biomass resources energize a healthy and prosperous California through the environmentally beneficial production and use of renewable energy, biofuels, and bioproducts.*

## Priority Areas

- Resource access and feedstock markets and supply
- Market expansion, access, and technology deployment
- **Research, development, and demonstration**
- Education, training, and outreach
- Policy, regulations, and statutes

## RD&D

- 📁 Resource Base, Sustainability and Access
- 📖 Bioscience/Biotechnology
- 📖 Biomass Conversion
- 📖 Feedstock Processing
- 📖 Systems Analysis
- 🕒 Knowledge/Information Resources



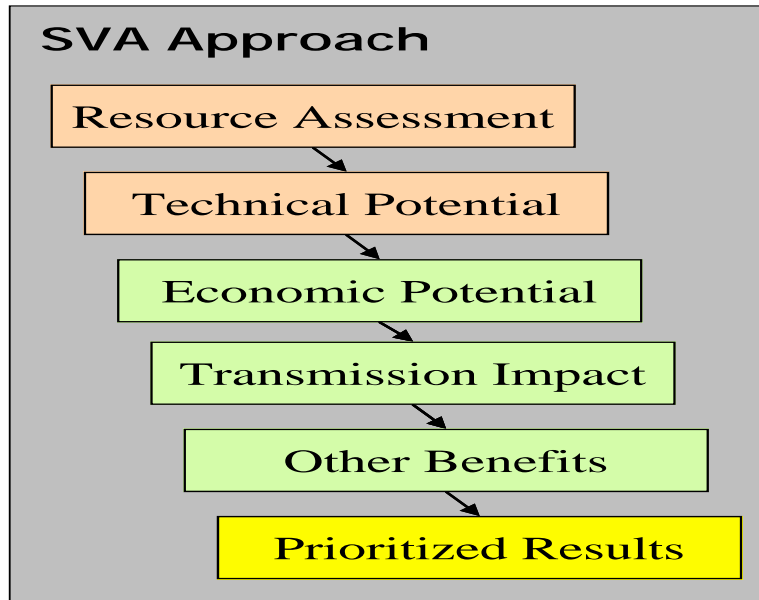
# PIER Biomass R&D Projects



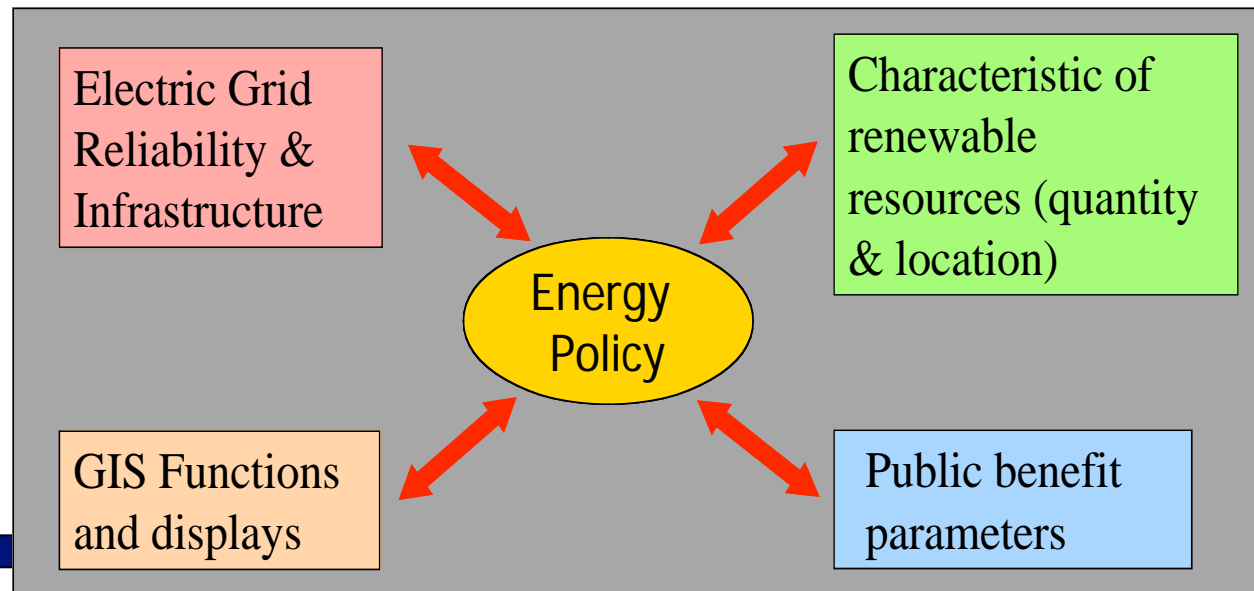


# Biomass SVA Methodology

## SVA Approach



- Biomass Resource Assessment – evaluate gross & technical potentials
- Characterize cost and performance biomass energy development
- Evaluate economic potential of biomass resources using GIS
- Power flow simulations that provide solutions that can defer transmission upgrades & reduce congestion
- Evaluate economics of biomass energy conversion technologies
  - Levelized cost of electricity (LCOE)
- Evaluate MW solutions that will meet RPS targets by 2010 and 2017



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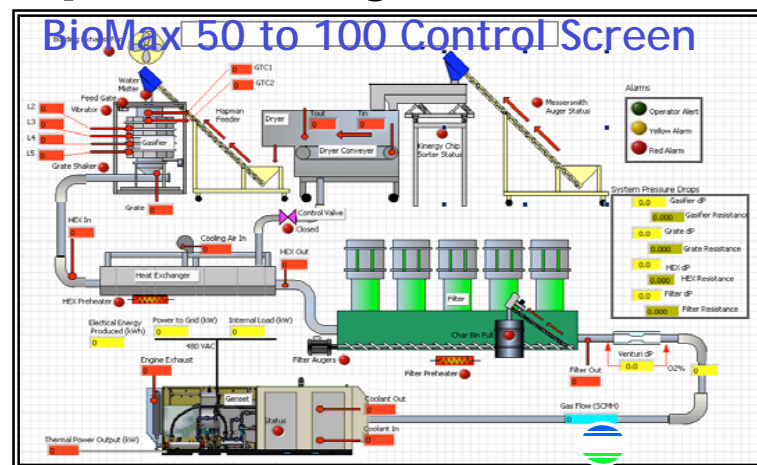
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# 50 kW Small Modular Biopower System

- Contractor: Community Power Corporation
- Goals:
  - Design, develop and demonstrate a 50 kW modular gasification system for grid interconnection, and combined heat and power using forest residue.
  - Improve cost competitiveness of the biomass energy conversion technologies and reduce environmental risks and costs of California's electricity.
- Project Site
  - Dixon Ridge, Winters, CA
- Status:
  - Completed the design and fabrication of the SMB components
  - Completed Shop testing at CPC
  - $\text{NO}_x = 0.39 \text{ lb/MWh}$  using catalytic converters
  - $\text{CO} = 4.47 \text{ lb/MWh}$
  - Field testing is ongoing

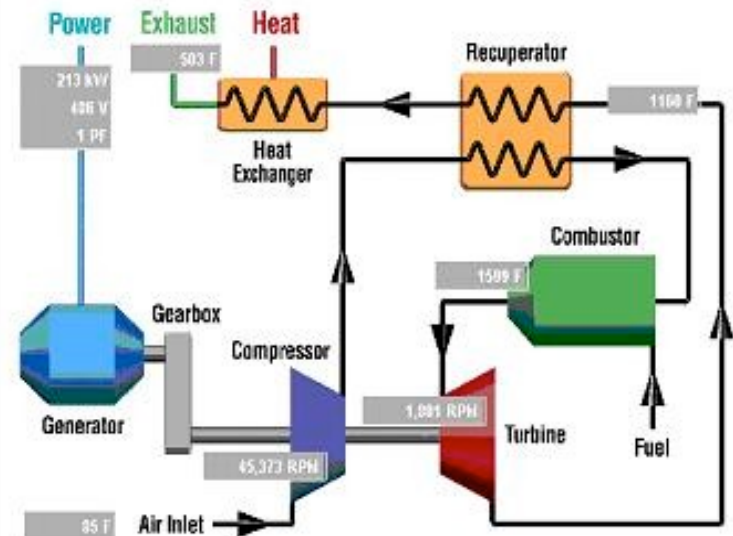


## 250 kW Microturbine Using Landfill Gas

- **Goals:**
  - Provide a low-cost high efficiency distributed power generation engine that runs on landfill gas
  - Efficiently use landfill gas to generate electricity (removing greenhouse gas from environment) while limiting emissions to very low levels
- **Project Team:**
  - SCS Engineers, Ingersoll-Rand & City of Burbank
- **Location:**
  - City of Burbank – Landfill No. 3
- **Results:**
  - Modified natural gas microturbine to accept landfill gas
  - Installed microturbine and balance of plant
  - Performed a seven-day reliability test
  - Completed 12-month demonstration test since June 23, 2005
  - Tested over 10,000 hours of operation with NO<sub>x</sub> emissions of 0.265 lb/MWh and availability higher than 90%



### 250 kW Microturbine Engine Cycle



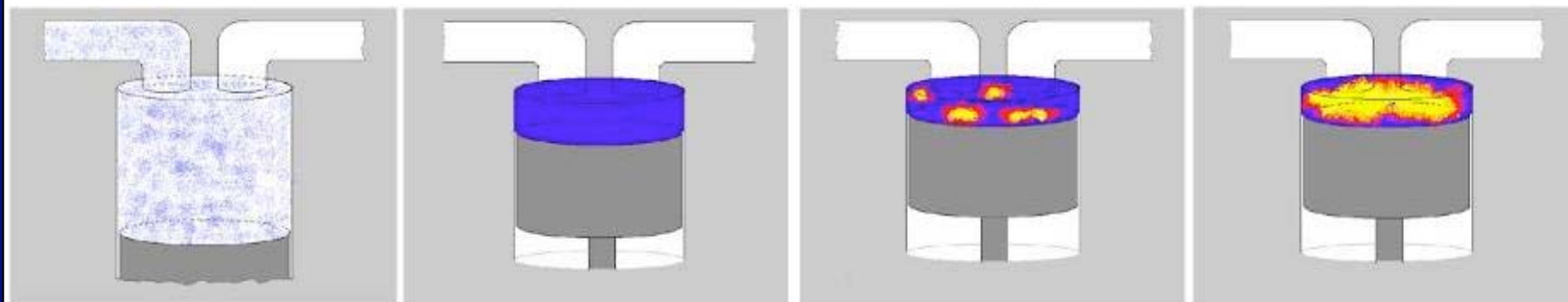


# HCCI using Landfill Gas

**Makel's HCCI:** (*homogeneous charge compression ignition*) Low NOx Generator – Butte County Landfill

Contractor: Makel Engineering

## The HCCI Combustion Process



Source: Per Amneus, Lund Institute of Technology

- Homogeneous mixture formed early in cycle
- Mixture compressed to high temperature and pressure
- Fuel/air chemistry results in ignition near top dead center
- Very rapid combustion event follows ignition

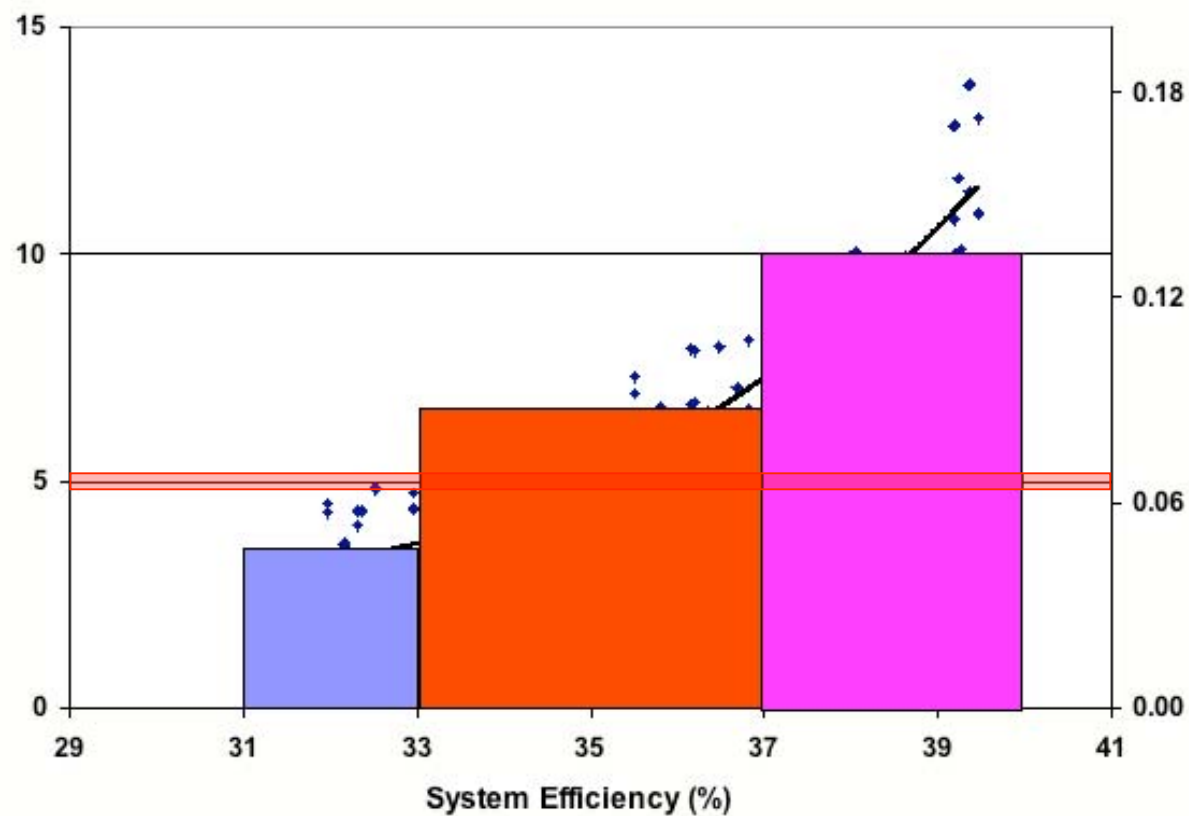


## Makel - Project Performance Goals

- System efficiency of 35% operating on LFG
- System stability of less than 10% efficiency variation
- System durability of greater than 10,000 hours between overhauls
- System NOx emission of approximately 5 ppm (0.07 lb/MW-hr)
- System cost of less than 750 \$/kW
- System electricity generation of less than 0.05 \$/kWh





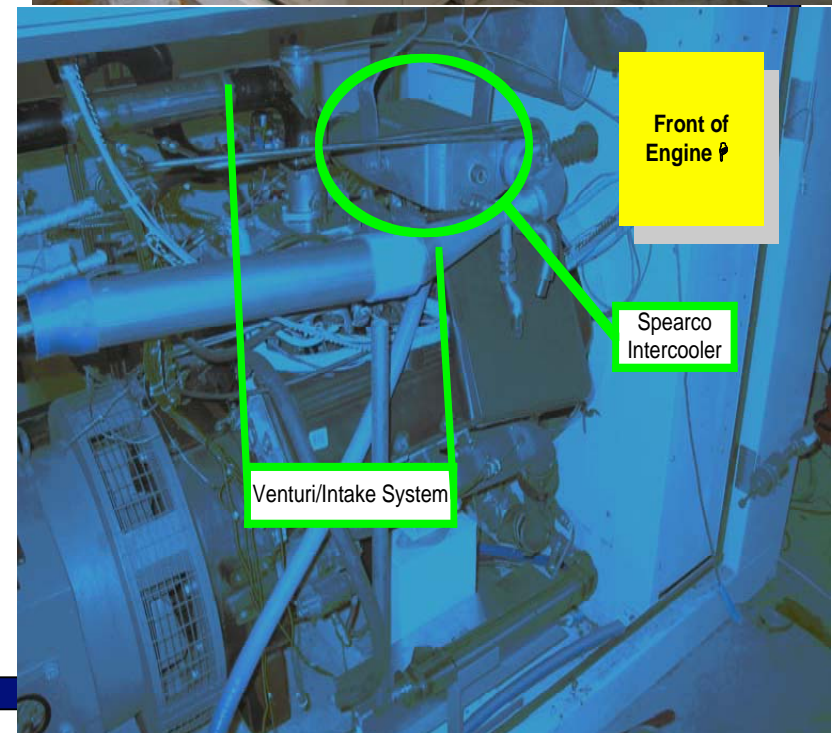


| EFFICIENCY (%) | NO <sub>x</sub> (ppm)-(lb/MW-hr)* |           |
|----------------|-----------------------------------|-----------|
| 37-39          | 8-14                              | (.10-.17) |
| 33-37          | 4-8                               | (.05-.10) |
| 31-33          | 2-4                               | (.03-.05) |



## Application of Hydrogen Assisted Lean Operation to Biogas-Fueled Reciprocating Engines (Bio-HALO)

- Contractor: **TIAX LLC**
- Goals:
  - **Demonstrate an innovative new engine system**
  - **With NOx emissions at 0.032 g/bhp-hr**
  - **Successful demonstration of a landfill gas autothermal reformer with 70% efficiency**
  - **Costs < \$1000/kW**
- Project Site:
  - **TBD**
- Status:
  - **Engine fabricated and tested on simulated landfill gas & synthetic reformat**



## BioHALO- NOx results Using simulated landfill gas & synthetic reformat

| IMEP (bar) | IMEP COV (%) | NOx (Corrected to 15 % O2) [ppm] | NOx (g/bhp hr, 15% O2) | H2 LHV/CH4 LHV | NOx (lb/MW hr), 15 % O2 |
|------------|--------------|----------------------------------|------------------------|----------------|-------------------------|
| 5.4        | 8.1          | 5                                | 0.035                  | 13.5%          | 0.10                    |
| 6.9        | 11.0         | 7                                | 0.044                  | 11.4%          | 0.13                    |
| 6.6        | 8.7          | 10                               | 0.071                  | 7.5%           | 0.21                    |
| 6.8        | 12.4         | 9                                | 0.078                  | 14.7%          | 0.23                    |
| N/A        | N/A          | 4                                | 0.043                  | 14.2%          | 0.13                    |
| 6.1        | 8.7          | 8                                | 0.044                  | 10.7%          | 0.13                    |
| 5.9        | 3.7          | 7                                | 0.047                  | 14.7%          | 0.14                    |
| 6.6        | 8.7          | 10                               | 0.071                  | 7.5%           | 0.21                    |



# Yolo County's BioReactor

- **Contractor: SMUD/Yolo Co.**
- **Goals:**
  - ❑ **Successful demonstration of bioreactor concept at full-scale**
  - ❑ **Accelerate decomposition of waste by 2/3rds normal timeframe**
  - ❑ **Document economic viability**
- **Project Site:**
  - ❑ **Yolo County landfill**
- **Status:**
  - ❑ Collected data shows that landfill bioreactor can accelerate organic portion of the solid wastes decomposition and methane recovery rates 4 to 7-fold as compared with conventional operation
  - ❑ The project has documented technical data needed to establish environmental and renewable energy benefits to help facilitate regulatory acceptance





## Valley Fig Growers' Anaerobic Digester for Food Wastes

- **Contractor:** Valley Fig Growers
- **Goals:**
  - ❑ *Demonstrate successful use of ADT for pre-treatment of food processing wastewater*
  - ❑ *Save ~ \$100,000/yr in waste discharge costs paid by VFG*
  - ❑ *Demonstrate CHP application of microturbine at site*
- **Project Site:**
  - ❑ **Valley Fig (Fresno)**
- **Status:**
  - ❑ Installed a covered lagoon that reduces BOD and SS by over 90% and generates 25 to 65 kW of electricity for use on-site
  - ❑ Save an annual cost of \$100,000 that VFG currently pays to the Fresno city
  - ❑ Reduce greenhouse gas (methane) emission at 148 tons per year
- **Awards Received**
  - ❑ A Certificate from the City of Fresno in recognition of the merits of biogas digester installed
  - ❑ An Honor Award in CELSOC's (Consulting Engineers and Land Surveyors of California) 2007 Engineering Excellence Award Competition



## Inland Empire Utility Agency (IEUA) Centralized Digester

- **Contractor:** IEUA
- **Project Location:** Chino, CA
- **Goals:**
  - Demonstrate a cost-effective European centralized digester for codigestion of dairy manure and food wastes
  - Generate 1.5 MW of electricity to be used on site
- **Status:**
  - Testing is ongoing





# UC Davis' High Solids Digester

- **Contractor: UC Davis & OnSite Power**
- **Goals:**
  - Scale up, test and demonstrate APS high solids digester
    - ◆ 3 tpd size at UC Davis
    - ◆ 25 tpd at Norcal Waste
  - Methane generation rate  $> 6 \text{ ft}^3 \text{ CH}_4/\text{lb of VS}$
  - Achieve CARB 2007 NOx goals
- **Project Site:**
  - UC Davis & City of Industry
- **Status:**
  - Digester construction is complete
  - Public Opening on October 24, 2006
  - Pilot testing is ongoing



# Biofuels Demonstration Program Status

- Funding of \$3 million awarded in 2007 to advance energy conversion technologies using cellulose biomass:
  - Metcalf & Eddy and San Francisco Public Utility Commission: Brown Grease Recovery and Biofuel Production Demonstration. Feedstock: fats, oil & grease
  - Renewable Energy Institute International: Demonstration of an Integrated Biofuels and Energy Production System. Feedstock: wood waste, rice straw
  - Bluefire Ethanol: First California cellulose to ethanol biorefinery project. Feedstock: green waste & wood waste. **Bluefire Ethanol declined to receive the award.**
- Funding agreements have been prepared for signatures by the Recipients.



# Biopower Demonstration Program Status

- Targeted Biopower Solicitation for Forest Biomass. With available funding = \$1 million to advance energy conversion technologies using forest biomass. Awarded 2 biopower projects.

**Growpro Inc. d.b.a. Cal-Forest Project: Develop and Operate a Wood Gasification System in a Commercial Environment in Northern California (\$199,500)**

This project will demonstrate a simplified gasification technology using forest residue. This technology will be upgraded with automated fuel dryer, feeding system and controls. The system will be operated for an extended period of time for power (33 kW) production and co-production of heat for greenhouse use.

**UCSD Projects: Power Generation Using Advanced Thermochemical Gasification of Biomass (\$499,857)**

This project will demonstrate the integrated co-generation of power (100 kW) from forest wood waste using an advanced thermochemical gasification process in parallel with the production of a high value added product, mixed alcohol (primarily ethanol) for blending with gasoline. Research and development issues related to technological hurdles and scientific baseline knowledge in areas of gasifier operation, producer gas combustion properties, producer gas clean up, engine performance and emissions, emission clean up, and engineering simulation tools will be investigated.



# PIER Renewables - Natural Gas Replacement Demonstration Program

Targeted Natural Gas Replacement with Renewables Solicitation. With available funding = \$2 million to advance energy conversion technologies replacing natural gas. Awarded 4 biomass projects.

## **1) Gas technology Institute: Production and Conditioning of High Sulfur Biogas for Fuel Cell Combined Heat and Power (CHP) Generation (\$499,921)**

The purpose of this project is to demonstrate onsite processing and anaerobic digester for converting onion peel waste products to biogas; and demonstrate high-sulfur biogas cleaning and conditioning to stringent fuel cell gas quality levels to displace natural gas fueling of two direct fuel cell power plants for combined heat and power generation.

## **2) Lawrence Berkeley National Lab: Biogas-Powered 100kW Microturbine with ultra-low Emission for CHP Applications (\$500,000)**

The purpose of this project is to develop and demonstrate a recuperated microturbine, with a low swirl ultra-low emission combustor, designed for operation as a combined heat and power system on biogas and capable of meeting the California Air Resources Board (CARB) 2007 DG emission standards for fossil fuels.



## PIER Renewables - Natural Gas Replacement Demonstration Program Cont'n...

### **3) Diversified Energy Corporation : Reducing California Industrial Natural Gas Consumption Through Advanced Biomass Gasification (\$500,000)**

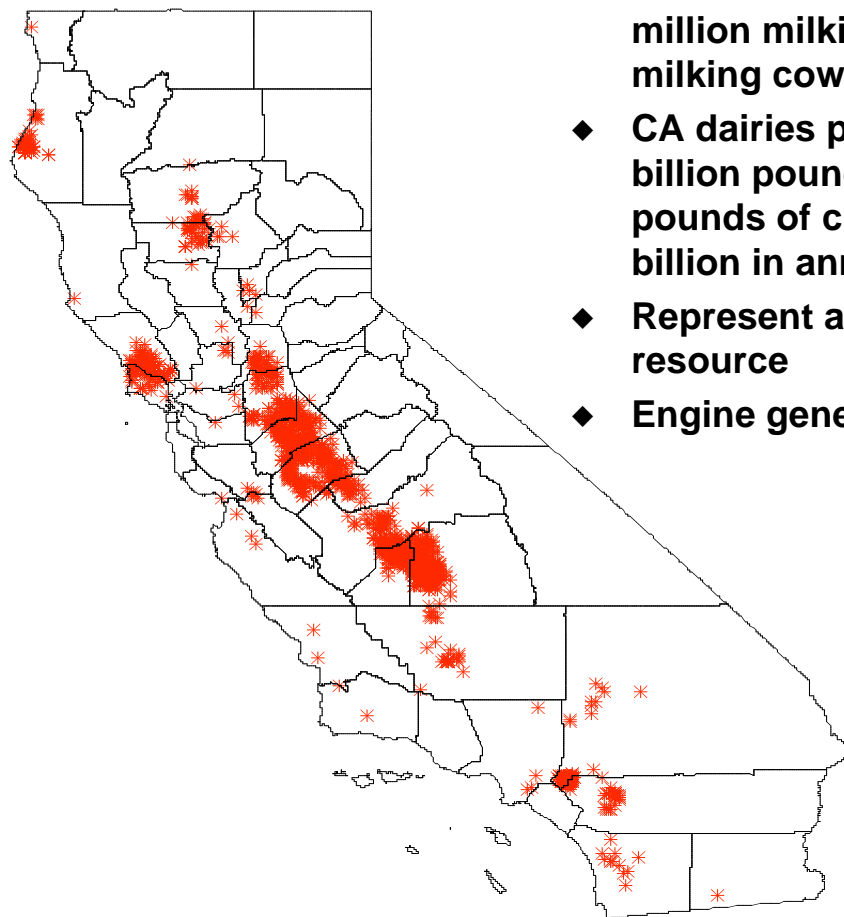
The purpose of this project is to develop and demonstrate an integrated biomass gasification project to convert waste wood fines into usable syngas for process heating.

### **4) Sacramento Municipal Utility District : Removal of Siloxane and H<sub>2</sub>S from Biogas Using Microwave Technology (\$267,381)**

The purpose of this project is to develop and demonstrate a biogas treatment system combining media adsorption and microwave treatment that can 1) remove siloxanes and H<sub>2</sub>S from biogas to allow post combustion technologies on engines, turbines and boilers to meet 2007 CARB emission standards, and 2) regenerate and reuse spent media at a cost less than existing disposal and replacement methods.



# Distribution of Dairies in California



- ◆ California is home to about 1.67 million milking cows – 18% of US milking cows
- ◆ CA dairies produce more than 27 billion pounds of milk, 1.25 billion pounds of cheese and generate \$3 billion in annual sales
- ◆ Represent a significant bioenergy resource
- ◆ Engine generators at 10 CA dairies





## Dairy Power Production Program

Biogas Digesters Installed at 11 Dairies in California & more to come



Castelani



Cottonwood



Hilarides



Straus



Laurenco



Meadowbrook



Van Ommering



Eden-Vale

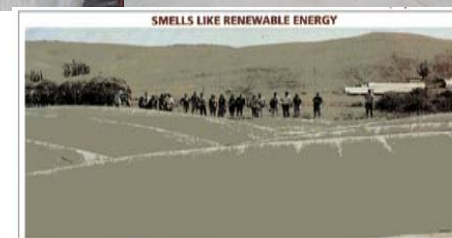


Koetsier



IEUA

- 11 systems funded ~ generating 3.3 MW total
- 6 covered lagoons and 5 plug flow digesters
- 7 new and 4 refurbished digester systems
- Lactating cows range from 245 to 7,931
- Dairy manure or mixture of dairy manure with cheese wastewater, creamery wastewater, and food processing wastewater



St Anthony Farm



## Renewable Energy Program Production Incentives for Biomass

- **Existing Renewable Facilities Program**

- Has helped 33 biomass facilities remain competitive or return to service by paying more than \$170 million for 640 MW of renewable energy capacity
- Provided \$6 million for the 2004 Agriculture-to-Biomass Program to improve air quality in CA's agricultural areas

- **New Renewable Facilities Program**

- SB 1036 recasts the Renewables Portfolio Standard program
- Eliminates the Renewable Energy Program's New Renewable Resources Account effective July 1, 2008
- Deletes the Energy Commission's authority to award supplemental energy payments and transfers administrative responsibility to the CPUC.
- Returns remaining New Account funds to electrical corporations
- Requires that the Energy Commission terminate all production incentives awarded prior to 2002 if the project didn't come online by 2007.
- Awards receiving funding are not affected.



# Renewables Portfolio Standard (RPS)

- **Investor Owned Utility RPS Biomass Contracts**

(signed since 2002)

- As of February 9, 2008, RPS solicitations and bilateral agreements have resulted in signed contracts with biomass facilities for 232-277 MW of capacity (range reflects build-out options).

- **RPS Certification**

- 97 biomass facilities are certified and 23 are pre-certified as eligible for the RPS representing 1,754 MW of capacity.



## Energy Efficiency and Biomass Generation Agricultural Loan Program

Available Funds: approximately \$3 million for an Agricultural and Food Industries Loan Program;  
Interest Rate: 3.2 percent

- Maximum loan amount: \$500,000 per applicant
- Funds are available for the design, purchase and installation of bio-energy technologies.
- Open solicitation, first-come-first-serve.

Status: Funded one biogas to energy project at Sacramento Municipal Utility District dairy farm to produce 230 kw of electricity. Loan documents have yet to be signed.



# Concluding Remarks

- **California has abundant biomass resources**
- **The PIER Program & Bioenergy Interagency Working Group and its member agencies are committed on making CA biomass resources part of the State's energy future**
  - **Planning and implementation of policy drivers**
  - **Resolving potential barriers to renewables development**
  - **Developing the next generation of biomass to energy conversion systems that will help make California's electricity and transportation fuels more cost competitive, reliable, safer and cleaner**
  - **Working closely and cooperatively with key stakeholders to meet California's special needs and take advantage of unique opportunities**
- **Develop Clean and Affordable Biomass Systems**
  - **Biogas & Biofuel systems that meet or exceed air & water quality standards**
  - **Small modular biomass systems that can help address electricity needs while simultaneously helping reduce wildfires and landfill capacity problems**
  - **Super clean, super-efficient biomass energy conversion systems with high strategic value to CA**



# Thank You

**Additional information** can be found at:

The Energy Commission's web site has extensive information on the ongoing bioenergy work in California at:

[http://www.energy.ca.gov/bioenergy\\_action\\_plan](http://www.energy.ca.gov/bioenergy_action_plan)

